

Implementation Monitoring of Forestry Best Management Practices for Harvesting and Site Preparation in South Carolina 1997-1999



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INTRODUCTION

Silvicultural guidelines for South Carolina were significantly updated in 1994 with the publication of *South Carolina's Best Management Practices for Forestry*. Compliance with Best Management Practices (BMPs) for harvesting has been surveyed three times in South Carolina. Overall compliance was 84.5% in the first survey in 1990¹, 84.7% in the second survey in 1991², and 89.5% compliance in 1994³, the most recent survey. Implementation monitoring of BMPs for site preparation was completed in 1996, and overall compliance was 86.4%⁴. The current study was designed to update the level of compliance with harvesting and site preparation BMPs statewide from previous surveys.

In previous surveys, monitoring sites were located, evaluated, and the results were published based on a single site visit. In the current survey, an expanded look at BMP implementation for harvesting and site preparation was used. Sites were located through aerial observation, permission was secured from landowners, and annual visits were made to each site over a three-year period. The initial site visit evaluated compliance with harvesting BMPs. One year later, a second site visit was conducted, and sites that received site preparation treatments were evaluated for compliance with site preparation BMPs. Sites that received no treatments during the first year post-harvest were examined to estimate site stabilization, conversion, and the effectiveness of BMPs implemented during the harvesting operation. Two years after harvest, a third and final site visit was made to each location. Sites that received site preparation treatments during the second year post-harvest were evaluated for compliance with site preparation BMPs. All tracts were evaluated for site stabilization, species and regeneration method used, conversion to other uses, and the presence of any ongoing erosion from silvicultural activities.

Harvesting BMP Compliance: Study Methods

During the summer of 1997, two hundred recently harvested sites were located from an aerial survey for evaluation of BMP compliance. Sites evaluated for BMP compliance were harvested between mid-1996 and mid-1997. The harvested sites were at least 10 acres in size, and were evaluated before site preparation occurred. No association with streams or wetland areas was required to be included as a monitoring site.



Figure 1. Two hundred harvested sites were evaluated for BMP compliance.

The sites selected for this survey were distributed in proportion to the volume of timber harvested in each county. The average volume of timber harvested in each county was based on annual timber harvest data collected by the U.S. Forest Service. The number of sites sampled in each county was in proportion to the

percent of that county's harvest in relation to the entire state. Sites were identified by SCFC foresters from fixed-wing aircraft (Figure 1).

Landowner Questionnaire

The BMP foresters contacted all landowners whose sites were selected for BMP compliance checks, and prior to the site inspection, landowners were questioned concerning their level of knowledge of BMPs, use of a professional forester, and use of a written sales contract. Four categories of landowners were identified for the purpose of this study:

1. Non-industrial private landowners who own less than 1,000 acres of forestland.
 2. Non-industrial private landowners who own more than 1,000 acres of forestland.
 3. Public lands, including both state and federal lands.
 4. Industrial lands.
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BMP Compliance Inspection

Site inspections were made during the spring and summer of 1997. The evaluations were made by the BMP forester and the project forester. BMP compliance was evaluated in each of five categories:

1. Road systems
2. Road stream crossings
3. Streamside management zones (SMZs)
4. Log decks
5. Harvesting systems

Each major category was evaluated on a pass/fail basis depending on the responses to a series of yes/no questions within each category.

Each harvesting operation was rated for overall BMP compliance after all individual BMPs were fully evaluated. Sites were given an overall rating of excellent, adequate, or inadequate depending on the level of BMP compliance. The overall compliance rating was based on compliance with specific BMPs as noted during the evaluation. On inadequate sites, the major problems were identified. Sites were rated as inadequate when water quality related BMPs were not followed and an evident in-stream water quality impact resulted.

Monitoring Results: Harvesting

BMP compliance checks were completed on 200 harvested sites in the summer of 1997. Compliance with each of the five major BMP categories and overall BMP compliance is summarized as follows.

98.6% Acceptable Road Systems

Of the 200 sites that were evaluated, 72 sites involved roadwork. BMPs for road construction and maintenance were considered separately from road stream crossings. Of the 72 sites that involved roadwork, only 1 site was rated as inadequate. This site was located in the piedmont region of the state, and received an inadequate rating due to poorly designed and inadequate water control structures on

roads. Compliance with road BMPs in this survey was higher than the 96% level of compliance reported in the last survey (Adams, 1994).

86.7% Acceptable Road Stream Crossings

Compliance with road stream crossing BMPs rose significantly from the previous survey, where compliance was 79.5% (Adams, 1994). 15 of the 200 sites surveyed involved the construction of road stream crossings. Of these 15 sites, 13 were designed, constructed, and maintained according to BMPs. Two sites were rated inadequate for road stream crossing BMPs. Both of these sites were located in the piedmont region of the state.

83.7% Acceptable Streamside Management Zones

Compliance with streamside management zone (SMZ) BMPs was 83.7% in this survey, compared to 79.9% in the last survey (Adams, 1994). Seventy-four of the 200 sites surveyed had perennial streams that required a SMZ. Statewide, 62 of these 74 sites had SMZs that were maintained according to BMPs. Twelve sites were rated inadequate because SMZs were not left or they did not follow the recommended BMPs. Inadequate ratings were given when the SMZ was harvested, woody debris was introduced into the stream, vehicles were used excessively within the SMZ, and when the SMZ was too narrow to protect the stream from sediment.

89.0% Acceptable Logging Systems

The harvesting operation was evaluated on each of the 200 sites included in this survey. Of these, 178 sites were rated as adequate. The practices evaluated when considering the logging systems included: (1) layout of the skid trails, (2) drainage crossings, (3) soil moisture conditions during logging, (4) degree of rutting, (5) percent of the area impacted by skidding equipment. Ruts were considered deep if they were over 10 inches deep. No sites received inadequate ratings for excessive rutting if there was no risk of impacts to water quality. Poorly designed skid trail stream crossings were present on 8 of the 200 sites that were inspected. Main skid trails were located within the primary SMZ on 7 of the 200 sites evaluated. The logging systems category is the only major category of BMPs where compliance was lower in this survey than in the previous survey, where compliance was 90.6% (Adams, 1994).

Overall BMP Compliance: Harvesting 91.5% Acceptable

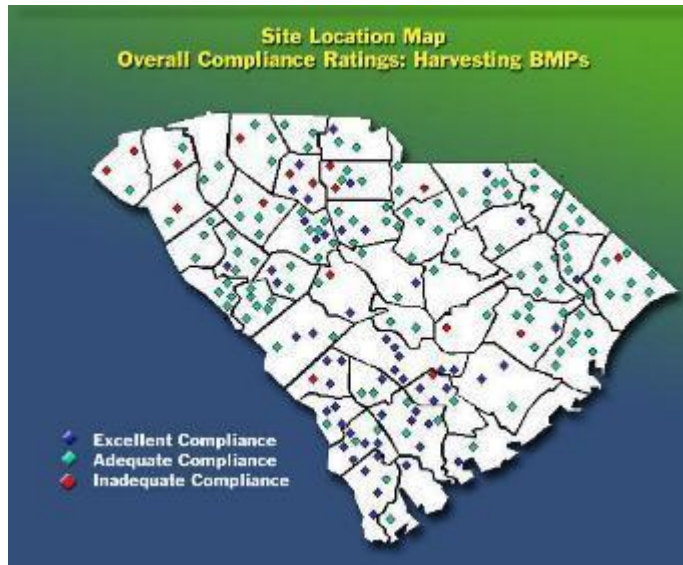


Figure 2. Of the 200 sites inspected for compliance with harvesting BMPs, 57 sites rated excellent, 126 sites rated adequate, and 17 sites rated inadequate.

Overall compliance with harvesting BMPs in South Carolina was 91.5% in this survey compared to 89.5% in the 1994 survey. Of the 200 sites inspected, 57 sites rated excellent, 126 sites rated adequate, and 17 sites rated inadequate. Eleven of the sites with inadequate ratings were located in the piedmont region of the state, and 6 of the inadequate sites were located in the coastal plain (Figure 2). On sites that were rated as inadequate, BMPs addressing streamside management zones and skid trail stream crossings appeared to be the most difficult categories of BMPs with which to comply (Figure 4).

Landowner Category

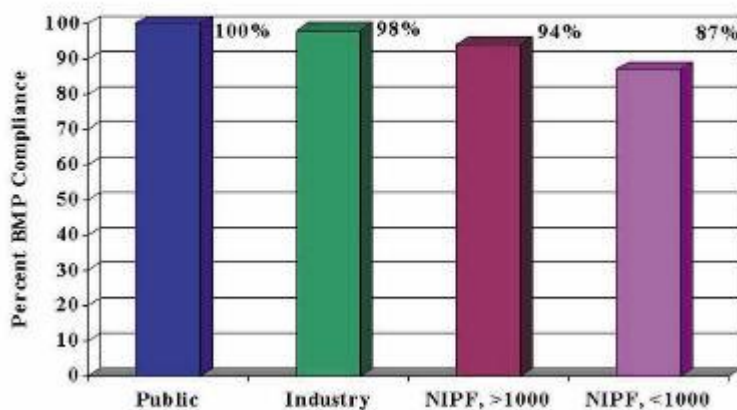


Figure 3. Compliance with harvesting BMPs, by landowner category.

Major Problems Identified On Inadequate Sites	
<u>Identified Problem</u>	<u>Number of Comments</u>
SMZ Harvested	11
Excessive Debris in channel	9
Poorly Designed Skid Trail	8
Stream Crossings	
Skid Trails within SMZ	7

Figure 4. Major problems identified on inadequate sites, harvesting BMPs.

Site Preparation Monitoring, 1 Year After Harvest

In January 1998, all of the monitoring sites were re-visited to evaluate compliance with site preparation BMPs. Additional information was gathered on several other variables, including site stabilization, conversion, and whether or not BMPs implemented during the harvest were still performing effectively. During this site visit, the entire site was examined to determine if site preparation had been conducted during the first year following the harvest. Particular attention was given to the problem areas noted during the initial site visit. If the tract had been site prepared during the first year after harvest, a BMP compliance inspection was done. The inspection covered compliance in each of four categories of site preparation:

- Mechanical treatments
- Herbicide applications
- Prescribed burning
- Minor drainage

Each category was evaluated on a pass/fail basis depending on the responses to a series of yes/no questions within each category. After each individual category was evaluated, each site preparation operation was rated for overall BMP compliance. Sites were rated as excellent, adequate, or inadequate depending on the level of BMP compliance.

If the site had not been site prepared after 1 year, information was collected on the site regarding site stabilization in both high traffic and light traffic areas. In light traffic areas, the percent bare ground was estimated in 5% increments. Percent bare ground on log decks and skid trails was estimated in 20% increments. This estimate was based on a walk-through of the site. Several other questions were answered for each site:

- Where implemented, are harvesting BMPs still effective?
 - Are road and stream crossings still functioning properly?
 - Have all erosion problems resulting from the harvest been stabilized?
 - Has the site been converted? What is the new use?
-

Site Preparation Monitoring, 2 Years After Harvest

In early 1999, each monitoring site was visited a third time. Sites that received site preparation treatments within the second year post-harvest were evaluated for compliance with site preparation BMPs. All 200 monitoring sites were evaluated to examine regeneration methods, species present, and the degree of site stabilization.

Sites that were site prepared during the second year after harvest were evaluated for compliance with site preparation BMPs, using the full site preparation form. On all sites, the following information was also gathered:

- Method of regeneration
- Species planted
- Species of non-planted trees present
- Number of trees per acre planted (spacing)
- Percent bare ground in light traffic areas
- Percent bare ground on heavy use areas (log decks & skid trails)
- Effectiveness of harvesting BMPs two years after harvest. Evidence of ongoing erosion resulting from the harvest operation
- Evidence of ongoing erosion resulting from the site preparation operation

Monitoring Results: Site Preparation

Within two years after harvest, 51% (102 of the 200) of the monitoring sites had been site prepared and regenerated. Each site that received site preparation treatments was evaluated for compliance with site preparation BMPs. Locations that were not site prepared and artificially regenerated were evaluated for site stability, natural regeneration, and other variables.

95.9% Acceptable

Mechanical Site Preparation

Statewide compliance with mechanical site preparation BMPs for all locations completed within 2 years after harvest was 95.9%. Of the 49 sites that were mechanically treated and regenerated, 47 sites had acceptable compliance with BMPs and 2 sites were rated as inadequate. Mechanical treatments were preferred on 48% of all monitoring sites that received site preparation treatments.

All of the monitoring locations in public ownership that were site prepared within the study period received some type of mechanical treatment. Mechanical methods were preferred on 55% of the survey sites owned by forest industry that received site preparation treatments. Large, non-industrial private landowners (owning >1,000 acres) used mechanical treatments on 33% of the sites in this ownership class, and small private non-industrial landowners (owning <1000 acres) used mechanical treatments on 36% of the sites in this ownership class that received site preparation during the study period.

The most common type of mechanical treatments used were shear/rake/bed, shear/bed, rake/disk, and roller drum chopping. None of the sites within jurisdictional wetlands had beds that connected to ditches, eliminating wetland drainage as a concern.

The two sites that received inadequate ratings for mechanical site preparation failed due to intensive mechanical site preparation on erodible soils and steep slopes. Poor windrow placement and inadequate protection of SMZs were also factors.

100% Acceptable Chemical Site Preparation

Chemical site preparation treatments were used on 51% (52 sites) of all monitoring sites that received site preparation treatments. Statewide, compliance with chemical site preparation BMPs on all of the sites receiving chemical treatments was 100%. Of the 52 sites receiving chemical treatments, 37 used herbicide treatments alone, 13 used herbicides in combination with prescribed burning, and 2 sites used a combination of herbicide and mechanical treatments.

The use of chemical site preparation treatments was most common on lands owned by small, private non-industrial landowners (owning <1,000 acres). On monitoring sites in this survey, this landowner class used chemical treatments 58% of the time. Large, private non-industrial landowners used chemical treatments 57% of the time, and sites owned by forest industry utilized chemical site preparation methods 45% of the time. None of the monitoring sites in public ownership used chemical site preparation methods.

100% Acceptable Prescribed Burning

Compliance with prescribed burning BMPs was 100% in this survey. A total of 19 sites used prescribed fire as part of the site preparation treatment. In the previous survey, compliance with prescribed burning BMPs was 70.4% (Adams, 1996) and the most common violations of BMPs involved the construction and stabilization of firebreaks around the sites. In this survey, no violations related to firebreak construction and stabilization were noted.

Prescribed fire was the least common site preparation treatment in this survey. Thirteen of the nineteen sites (68.4%) used prescribed burning in combination with herbicide use for site preparation, and six sites (31.6%) utilized prescribed burning alone. The use of prescribed burning was most common in the Southern Coastal Plain region (47.4%), and lowest in the Carolina sandhills region (10.5%).

The use of prescribed burning varied among landowner categories. Of the sites that utilized prescribed burning as a site preparation tool, 74% were owned by non-industrial private landowners. Forest industry owned 21% of the sites that were prescribed burned, and public ownership accounted for 5%.

Minor Drainage

No drainage activities occurred on any sites included in this monitoring survey. In the previous survey of site preparation BMP implementation, compliance with BMPs related to minor drainage was 76.9% (Adams, 1996). Several possibilities exist that may explain why no monitoring sites received minor drainage:

- Increased awareness of laws concerning wetland modification
- Increased awareness of site preparation BMPs related to wetland issues such as minor drainage and hardwood to pine conversion
- Increased commitment to BMP education by forest industry

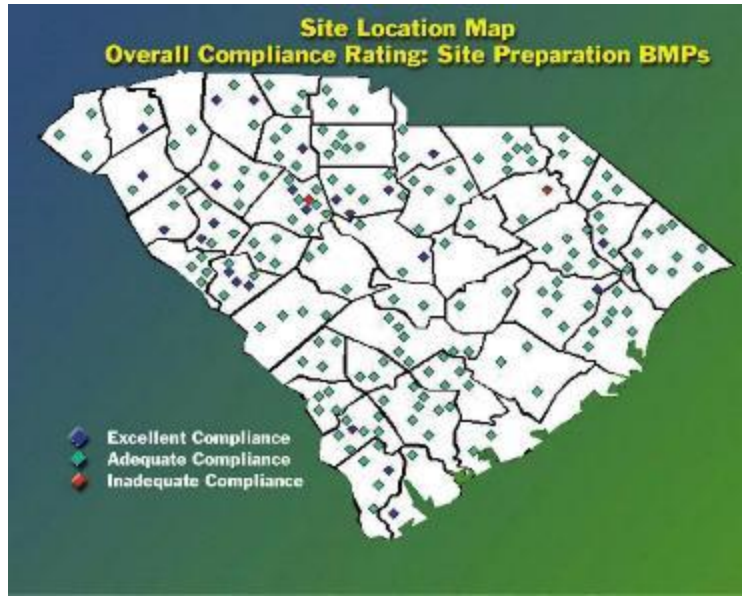


Figure 5. Of the 102 locations site prepared, 24 sites rated excellent, 76 sites rated adequate, and 2 sites rated inadequate.

Overall BMP Compliance: Site Preparation 98% Acceptable

Overall compliance with site preparation BMPs in South Carolina was 98.0% in this survey compared to 86.4% in the 1996 survey. Of the 102 sites receiving treatments, 24 sites rated excellent, 76 rated adequate, and 2 sites rated inadequate. One of the inadequate sites was located in the piedmont region of the state, and one was located in the coastal plain. Both of the sites that were rated as inadequate utilized mechanical treatments, and BMPs addressing SMZ protection, high intensity treatments on steep slopes, and windrow placement appeared to be the most difficult categories of BMPs with which to comply (Figure 5).

Conversion

Within the monitoring period, 3% (6 out of 200) of the sites were converted to uses other than silviculture. Of these, 5 were converted to residential use and 1 was converted to agriculture. To be considered converted, at least 50% of the tract was removed from silviculture.

Regeneration

During the final visit to each monitoring site, estimates were made of the amount of planted and non-planted regeneration. Estimation techniques were different for artificially regenerated and naturally regenerated sites.

On sites that were artificially regenerated, the number of planted trees per acre were estimated, based on tree spacing and landowner survey information. Non-planted species were estimated within a range of densities, and the three most commonly occurring species on the site were noted in order of prevalence. The most common naturally occurring species on site prepared and planted sites were:

- loblolly pine (predominant species on 34% of sites)
- oak species (predominant species on 28% of sites)
- sweetgum (predominant species on 26% of sites)

Longleaf pine was the species of choice for artificial regeneration on 97% (99 of 102) of the sites. On the remaining 3% of the artificially regenerated sites (3 of 102) loblolly pine was planted. Hand planting was the preferred method on 99% (101 of 102) of the sites. Only one monitoring site was planted using a mechanical tree planter. On most sites, trees were planted on spacings of 8X8 or 7X10, at 49% and 28% respectively. On artificially regenerated tracts, the number of trees per acre of planted and non-planted species were noted.

On sites that naturally regenerated, the total number of trees per acre was estimated. Individual tree species were noted in order of prevalence. The most common species occurring on naturally regenerated sites were:

- loblolly pine (predominant species on 44% of sites)
- sweetgum (predominant species on 24% of sites)
- oak species (predominant species on 12% of sites)

Stocking levels of natural regeneration varied among all monitoring sites. The density of non-planted species present on any given site was dependent on a combination of factors, including:

- method of site preparation used
- time of year site preparation occurred
- length of time between site preparation and site visit
- soils present
- availability of seed source

Among naturally regenerated tracts, 91.6% were well-stocked or higher (>300 trees per acre) two years after harvest. The number of non-planted trees per acre occurring on artificially regenerated sites was estimated as high (>700 trees per acre), moderate (3-700 trees per acre), or low (<300 trees per acre). The majority of these sites, 77.4% (79 of 102), had low densities of non-planted species present after site preparation. Only 12.7% (13 of 102) of the sites had a high density, and 9.8% (10 of 102) had moderate density.

Site Stabilization

The degree of site stabilization was estimated one year after harvest and two years after harvest on both light traffic and high traffic areas. One year after the harvest, 87% of the sites had a high degree of site stabilization on light traffic areas (0-5% bare ground). On high traffic areas such as log decks and main skid trails, 76% of the sites had high stabilization (0-20% bare ground). Two years post-harvest, 88% of the sites had a high degree of stabilization on light traffic areas and 89.5% had high stabilization on log decks and skid trails (Figure 6).

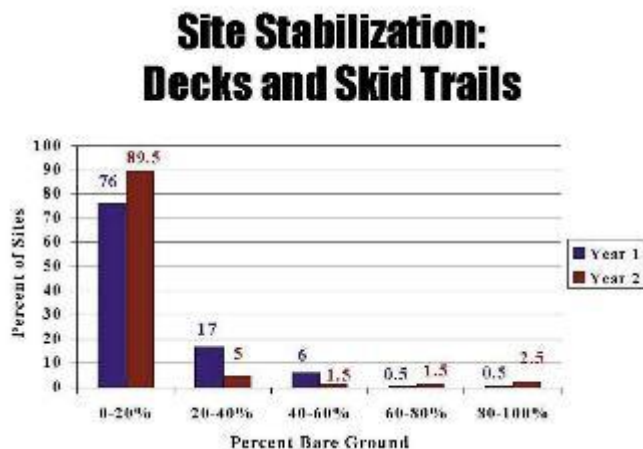


Figure 6. Degree of site stabilization on high-traffic areas, one and two years after harvest.

Availability of Cost-share Assistance

Another potential factor affecting the length of time between harvest and regeneration is the availability of cost-share assistance. Some landowners, particularly small NIPF landowners, may delay site preparation and regeneration until cost-share money is available. Of the 98 monitoring sites where no site preparation activities were completed within 2 years of the harvest, only 7 (7.1%) were awaiting cost-share assistance.

Rate of Site Preparation Among Landowner Classes

The rate at which a location was site prepared and regenerated differed between landowner class. Within one year of harvest, 26% of the publicly owned tracts, 40% of the tracts owned by forest industry, 22% of the tracts owned by large private landowners (>1,000 acres), and 17% of the tracts owned by small private landowners (<1,000 acres), had been site prepared and regenerated. At the end of the study, 84% of the sites owned by forest industry had been site prepared and regenerated, and the lowest percentage completed was by private landowners. Non-industrial private landowners owning less than 1,000 acres site prepared and artificially regenerated 36% of the sites within this landowner class; non-industrial private landowners owning more than 1,000 acres site prepared 44% of the sites within their landowner class. Sixty-six percent of the publicly owned sites were site prepared and artificially regenerated during the monitoring period (Figure 7).

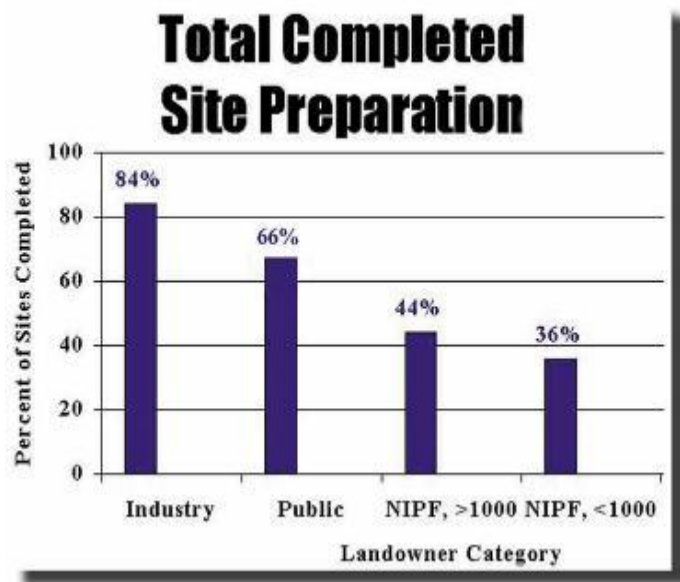


Figure 7. Percent of tracts site prepared and regenerated two years after harvest, by landowner class.

SUMMARY AND CONCLUSIONS

In this re-evaluation of compliance with BMPs in South Carolina, monitoring sites were visited annually for 3 years to determine compliance with harvesting BMPs, site preparation BMPs, and to investigate regeneration practices and methods. A total of 200 sites were included in this monitoring survey.

Compliance with silvicultural BMPs for harvesting was 91.5% in this survey. Four major categories were evaluated during the initial site visit: road systems, stream crossings, streamside management zones, and harvesting systems. Compliance was highest for BMPs related to road systems, 98.6%. Compliance with BMPs relating to harvesting systems was 89.0%, with the major problems consisting of skid trail design and placement, skid trail stream crossings, and harvesting under wet conditions. Compliance with BMPs for road stream crossings was 87.0% due primarily to improper design and placement of stream crossings. The lowest BMP compliance was related to SMZ protection, 83.7%.

In this survey, compliance with BMPs for site preparation was 98%. Sites were visited one year after the harvest and again two years after the harvest. Sites were evaluated for compliance with site preparation BMPs during the first visit after the site preparation was completed. Each site was evaluated in each of the four major site preparation categories that were implemented: mechanical treatments, chemical treatments, prescribed burning, and minor drainage. Two years after the harvest only 51% (102 out of 200) of the monitoring sites had been site prepared and artificially regenerated. BMP compliance was

highest for prescribed burning and chemical treatments which both had 100% compliance. Mechanical treatments had 96% compliance, the lowest level in this survey, but only slightly lower than the compliance rate for other site preparation treatments. No sites included in this survey received minor drainage as a treatment.

Additional information was gathered during the second and third site visits to determine site stabilization, regeneration methods used, and the amount of natural regeneration. Based on visual estimates of groundcover present, even high traffic areas on monitoring sites were well-vegetated within two years of harvest, even if soil-disturbing activities like mechanical site preparation were carried out. This indicates that naturally occurring grasses and annual vegetation are generally stabilizing harvested sites after one growing season.

Regeneration methods were also noted when sites had been artificially regenerated. On 99.2% of the sites, hand planting was the preferred method. Only one monitoring site was reforested using a machine planter.

On planted sites, loblolly pine was the species of choice 97% of the time. The remaining 3% of sites were reforested with longleaf pine. On most sites, trees were planted on spacings of 8x8 or 7x10, at 49% and 28% respectively. On all sites estimates were made to determine the number of trees per acre of planted and non-planted species present. Two years after harvest, 91.6% of locations where no site preparation or artificial regeneration occurred were well-stocked or higher. On sites that were site prepared and artificially regenerated, the amount of non-planted regeneration was highly variable, depending on many factors, including the method and timing of site preparation utilized.

Recommendations

Since its inception, the SCFCs Forestry BMP program has demonstrated that a non-regulatory approach to preventing and minimizing non-point source pollution from silviculture activities can be effective. Proactive methods, including the offer of Courtesy BMP Exams and periodic monitoring of BMP compliance encourage implementation of the voluntary BMPs. In addition, participation in the South Carolina Forestry Association's Timber Operations Professional Training and the cooperation of forest industry through the Sustainable Forestry Initiative have increased awareness of the important role BMPs play in protecting water quality and site productivity.

To further improve compliance and understanding of BMPs, the following suggestions should be implemented:

- Existing BMP education and training programs should be periodically updated and revised to reflect the problem areas noted in monitoring surveys.
- BMP programs should emphasize the selection of the appropriate site preparation method for each site, based on the parameters provided in the BMP manual. In particular, training for mechanical site preparation should be developed.
- Educational programs should be developed to increase awareness of the importance of SMZ protection, and to provide training and explanation of the recently released BMPs for Braided Streams.
- Periodic monitoring of BMP implementation should be continued to document success in preventing pollution for silvicultural activities, and to determine areas where additional training is necessary.
- Partnerships with forest industry, the South Carolina Forestry Association, and State and Federal regulatory and natural resource agencies should be maintained to ensure consistent application of BMPs.

¹ Hook, D.D., W. McKee, T. Williams, B. Baker, L. Lundquist, R. Martin, and J. Mills. 1991. A Survey of Voluntary Compliance of Forestry Best Management Practices. South Carolina Forestry Commission. Columbia, South Carolina. 23 p.

²Adams, T. and D. Hook. 1993. Implementation and Effectiveness Monitoring of Forestry Best Management Practices on Harvested Sites in South Carolina. South Carolina Forestry Commission. Columbia, South Carolina. 32 p.

- ³ Adams, T. 1994. Implementation Monitoring of Forestry Best Management Practices on Harvested Sites in South Carolina. South Carolina Forestry Commission. Columbia, South Carolina. 24 p.
- ⁴ Adams, T. 1996. Implementation Monitoring of Forestry Best Management Practices for Site Preparation in South Carolina. South Carolina Forestry Commission. Columbia, South Carolina. 24 p.